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# (12) UK Patent Application (19) GB (11) 2 278 902 (13) A

(43) Date of A Publication 14.12.1994

(21) Application No 9311773.7

(22) Date of Filing 08.06.1993

(71) Applicant(s)  
Millfield Enterprises Limited

(Incorporated in the United Kingdom)

16 Shelley Road, Newburn Industrial Estate,  
Newburn, NEWCASTLE UPON TYNE, NE15 9RT,  
United Kingdom

(72) Inventor(s)  
John Marshall Dodd

(74) Agent and/or Address for Service  
Reid Sharpe  
St Nicholas Chambers, Amen Corner,  
NEWCASTLE-UPON-TYNE, NE1 1PE, United Kingdom

(51) INT CL<sup>5</sup>  
E21D 21/00, E02D 5/80

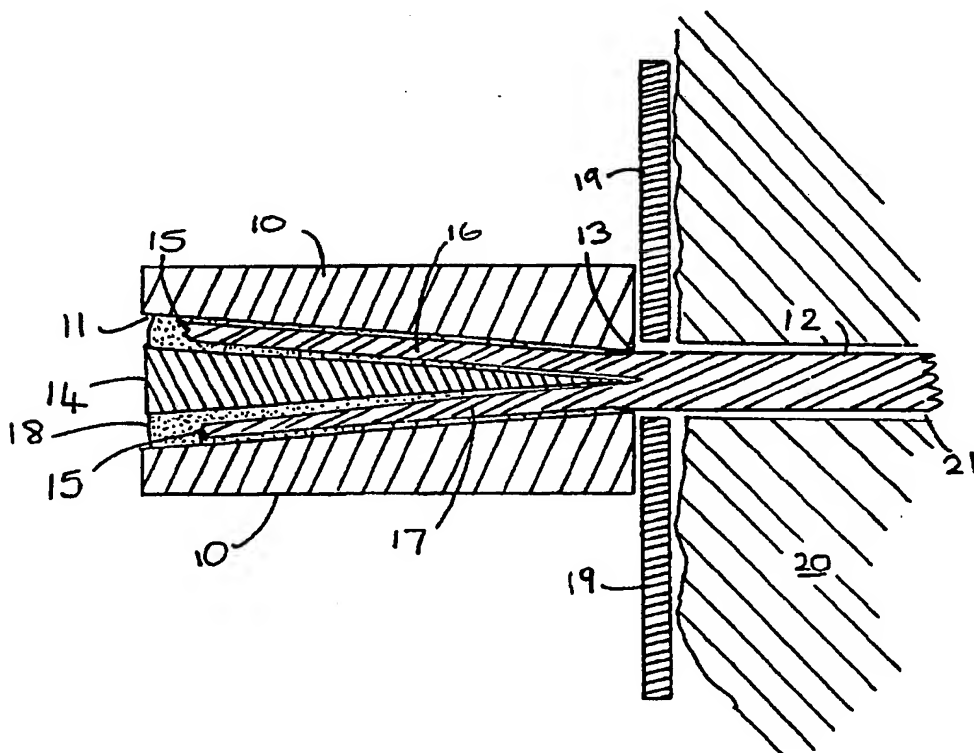
(52) UK CL (Edition M )  
F2H HAV  
U1S S1247 S1702

(56). Documents Cited  
US 4444529 A US 4369003 A

(58) Field of Search  
UK CL (Edition M ) F2H HAV  
INT CL<sup>5</sup> E02D 5/80, E21D 21/00

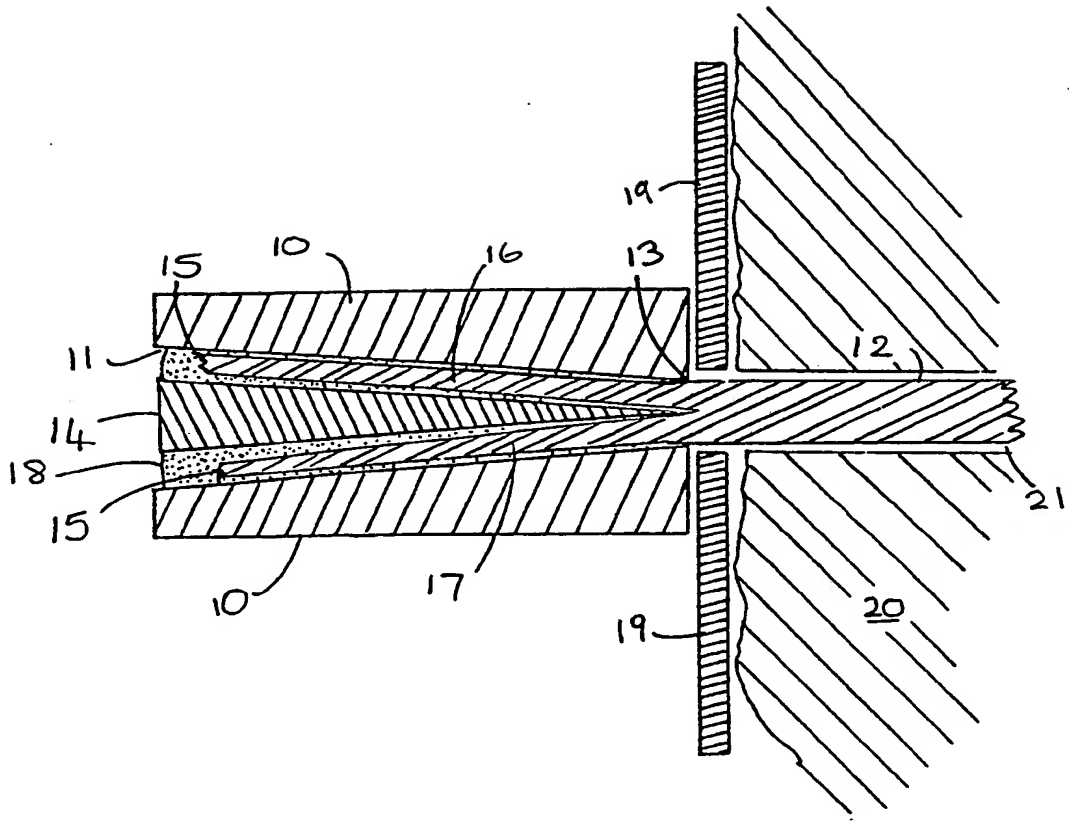
## (54) End-fixing apparatus

(57) A fixing apparatus for securing the end of a length of elongate material (12) comprises a rigid body (10) having a tapered aperture (11) extending therethrough, a retaining pin (14) of such dimensions as to be able to extend into the tapered aperture and tapered at an angle generally comparable to that of the tapered aperture and a resin (18) for bonding the retaining pin (14) to the elongate material. A method of securing an end of length of elongate material using the fixing apparatus is also described. The apparatus and method may be used to secure the ends of ground anchors, for example.



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End Fixing Apparatus.

The invention concerns fixing apparatus for securing an end of a length of rigid rod, tube or similar materials in a fixed position in such a way that the rod or the like is resistant to movement along its length away from the point of fixing. Such apparatus may be used in a variety of technical fields but is especially useful in securing the ends of ground anchors, roof bolts or stays for radio masts.

It is known to secure the ends of rigid rods simply by applying to their threaded end an appropriately threaded end piece or nut. However, rods made from reinforced plastics materials, which are able to resist corrosion and which are strong in tension, have threads which tend to fail at a much lower tensile force than the elongated part of the rod.

The present invention is an apparatus and method for securing the ends of rods and the like which does not rely upon a threaded connection.

The invention is a fixing apparatus for securing the end of a length of elongate material, which comprises a rigid body having a tapered aperture extending therethrough, a retaining pin, of

such dimensions as to be able to extend into the tapered aperture and tapered at an angle generally comparable to that of the tapered aperture and a resin for bonding said retaining pin to said  
5 elongate material.

The invention further comprises a length of elongate material secured at at least one end by a fixing apparatus comprising a rigid body having a tapered aperture therethrough, a retaining pin of  
10 such dimensions as to be able to extend into the tapered aperture and tapered at an angle generally comparable to that of the tapered aperture and a resin for bonding said retaining pin to said end of said length of elongate material.

15 The invention further comprises a method of securing the end of a length of elongate material by inserting the end of the length through the smaller end of a tapered aperture extending through a rigid body, inserting a retaining pin of such dimensions  
20 as to be able to extend into the tapered aperture and tapered at an angle generally comparable to that of the tapered aperture, through the wider end of the tapered aperture and into the end of the length of elongate material so as to widen said end of  
25 material to prevent it from being readily withdrawn through the smaller end of said aperture and introducing a resin into the tapered aperture so as to bond said retaining pin to said end of the length

of elongate material.

The use of such apparatus and method in securing the end of a length of material allows an increased proportion of the tensile strength of the material to be exploited, eliminating the weakness inherent in a threaded end connection.

The rigid body having a tapered aperture is of appropriate dimensions having regard to the particular end to be secured and its desired location. The tapered aperture extends through the rigid body. It is preferably of regular cross-section e.g. hexagonal or square, but is most preferably round, the aperture being frustoconical in this case.

The external form of the rigid body may be of any size and shape suitable for the particular circumstances of use but in a preferred form is a cylinder. The ends of the rigid body may be flat or shaped. The surfaces of the two ends may not be parallel.

In one preferred embodiment, the end of the rigid body through which the narrower part of the tapered aperture extends is rounded or dome-shaped. This form of the rigid body is especially useful for use in situations where the elongate material and end fixing are not perpendicular to the surface

against which the fixing is to bear. In such situations, the dome-shaped end allows a more even distribution of the forces between the fixing and the surface than a fixing in which the end surfaces of the rigid body are generally parallel planes.

The retaining pin is of such a length and cross-section that it can extend partially or fully into the tapered aperture of the rigid body. Its angle of taper is generally similar to that of the tapered aperture. The shape of its cross-section may be similar to that of the tapered aperture or it may be different. In one preferred form of the invention the retaining pin is of circular cross-section, i.e. it is conical in shape. However the shape of the cross section of the retaining pin may vary along its length. Its cross-sectional area relative to that of the aperture is selected according to the thickness and type of material to be secured.

The rigid body and the retaining pin may each be formed of steel or other suitable metal such as die-cast aluminium, synthetic composite materials or cast resin such as epoxy resins or polyesters.

The length of elongate material to be secured may be a rod or tube of deformable metal or synthetic material, including woven carbon fibre. In a preferred form the material to be secured is a

rigid rod or tube of fibre-reinforced plastics material.

5 The resin is preferably a curable resin which is introduced into the tapered aperture when the retaining pin has been inserted into the end of the length of material. The resin, when cured, forms a rigid casting which wholly or partially surrounds the end of the material and retaining pin and which conforms to the shape of the tapered aperture. In 10 this way the end of the length of material is bonded to the retaining pin and is, in effect, formed into a solid mass similar in size and shape to the tapered aperture and which cannot be readily withdrawn through the smaller end of the tapered 15 aperture.

The resin is preferably an epoxy or polyester compound and is most preferably a polyester.

20 The invention may be applied to secure an end of a length of elongate material in its final desired position, for example at a rock face to be stabilised, or it may be applied to an elongate material which is then put into position. Rods, for example, may be pre-fitted with a fixing apparatus according to the invention and may be placed in 25 position, in a prepared cavity for example, subsequently.



A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawing which is a longitudinal section through a rigid rod used as a ground anchor and secured by the end fixing apparatus according to the invention.

A rigid rod of glass-reinforced plastics material 12, formed by "pultrusion", is shown having been positioned in a long circular bore 21 drilled into a rock face 20. The space between the rod and the surface of the rock along the bore may be filled with a resin. The end of the rod 12 protrudes from the rock face and passes through a hole in a steel plate 19 and into the rigid body 10 of the end fixing apparatus, through the smaller end 13 of the tapered aperture provided.

The rigid body 10 is a cylinder formed of mild steel having a tapered aperture 11 of circular cross-section extending through it along its longitudinal axis. A tapered retaining pin 14 of circular cross-section, has been forcibly inserted into the end 15 of the rod 12 and has caused the end portion of the rod to split along its length into several sections 16, 17. The insertion of the pin and splitting of the rod is made easier and more controllable if cuts are made in the end of the rod to initiate the splitting process. The rod splits

along its length rather than in other directions because of the orientation of the fibre reinforcement of the plastics material, which gives the rod its superior tensile strength.

5           Finally, an epoxy resin 18 has been introduced into the tapered aperture. When cured, the resin, together with the rod sections 16, 17 and the retaining pin 14, form a conical shaped block which cannot be withdrawn through the narrow end of the  
10 tapered aperture 13. The rod is therefore anchored in a fixed position relative to the plate 19 and the rock 20.

CLAIMS

1. A fixing apparatus for securing the end of a length of elongate material, comprising a rigid body having a tapered aperture extending therethrough, a retaining pin of such dimensions as to be able to extend into said tapered aperture and tapered at an angle generally comparable to that of the tapered aperture and a resin for bonding said retaining pin to said elongate material.
2. A fixing apparatus as claimed in claim 1, wherein said tapered aperture is of regular cross-section.
3. A fixing apparatus as claimed in claim 2, wherein said cross-section is square or hexagonal in shape.
4. A fixing apparatus as claimed in claim 2, wherein said cross-section is round in shape.
5. A fixing apparatus as claimed in any of claims 1-4, wherein said rigid body has the external form of a cylinder.
6. A fixing apparatus as claimed in any of claims 1-5, wherein the end of the rigid body through which the narrower part of the tapered aperture extends is rounded or dome-shaped.

7. A fixing apparatus as claimed in any of claims 1-6, wherein said retaining pin is of circular cross-section.

5 8. A fixing apparatus as claimed in any of claims 1-7, wherein said rigid body and/or said retaining pin are formed of metal, cast resin, or of a synthetic composite material.

10 9. A fixing apparatus as claimed in any of claims 1-8, wherein said resin is a curable resin.

10. A fixing apparatus as claimed in claim 9, wherein said curable resin is an epoxy or a polyester compound.

15 11. A length of elongate material secured at at least one end by a fixing apparatus as claimed in any of the preceding claims.

12. A length of elongate material as claimed in claim 11, which is a rod or tube of deformable metal or synthetic material.

20 13. A length of elongate material as claimed in claim 12, which is a rigid rod or tube of fibre-reinforced plastics material.

14. A method of securing the end of a length of elongate material by means of an apparatus as claimed in any of claims 1 to 10, which method comprises inserting said end through the smaller  
5 end of said tapered aperture, inserting said retaining pin through the wider end of said tapered aperture and into the end of said elongate material so as to widen said end of material to prevent it from being withdrawn  
10 through said smaller end of said aperture, and introducing a resin into said tapered aperture so as to bond said retaining pin to said end of said elongate material.

15. A method as claimed in claim 14, wherein  
15 said elongate material is a rod or tube of deformable metal or synthetic material.

16. A method as claimed in claim 15, wherein said elongate material is a rigid rod or tube of fibre-reinforced plastics material.

20 17. A method as claimed in any of claims 14 to 16, wherein said end of said elongate material is inserted into said tapered aperture at the desired position of use of said material.

18. A method as claimed in any of claims 14 to  
16, wherein said end of said elongate material  
is inserted into said tapered aperture before  
said material is put in its desired position of  
5 use.

19. A method of securing the end of a length of  
elongate material, which method is substantially  
as hereinbefore described with reference to the  
accompanying drawings.

Patents Act 1977  
Examiner's report to the Comptroller under Section 17  
(The Search report) - 12 -

Application number  
GB 9311773.7

**Relevant Technical Fields**

- (i) UK Cl (Ed.M) F2H (HAV)  
(ii) Int Cl (Ed.5) E21D 21/00, E02D 5/80

Search Examiner  
T S Sutherland

Date of completion of Search  
16 August 1994

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant  
following a search in respect of  
Claims :-  
1-18

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Category	Identity of document and relevant passages	Relevant to claim(s)
A	US 4444529 (OY)	
A	US 4369003 (GEBIRGSSICHERUNG)	

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